

Fugitive Dust Control at the Salton Sea: Selection of Control Measures

Agrarian Research
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OVERVIEW

- There are potentially at least 4 dust control measures (DCM's), only 2 were implemented at Owens Lake
- It is better to have more solutions available. Playa surface heterogeneity can limit implementation and performance of individual measures.
- Any DCM implementation mix needs some very resource- efficient measures
- Planning and selection strategies:
 - Don't underestimate dust footprint
 - Don't underestimate costs by only considering partial first costs; need to do FAC and LCC for each measure proposed

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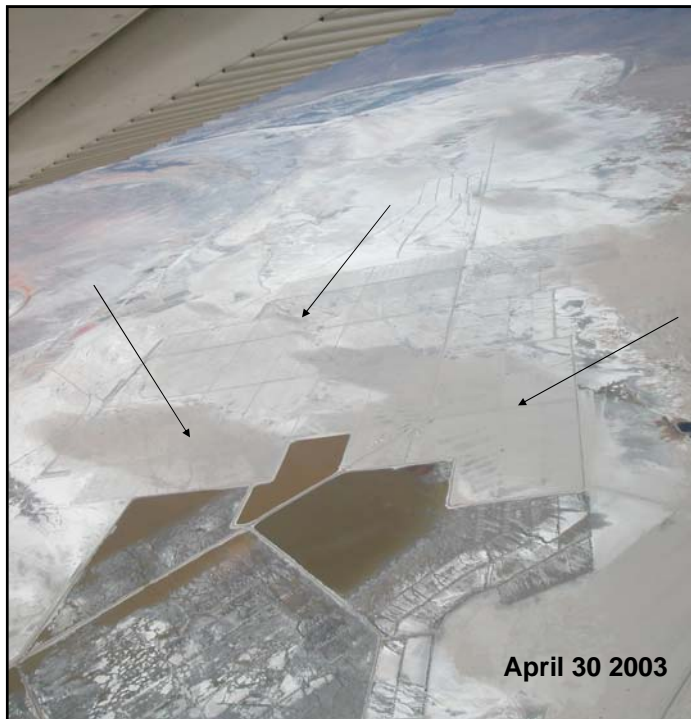
- Proposed Measures
 - Description
 - Appropriate locations
- Methods of evaluation
 - Effectiveness
 - Efficiency
 - Full absorption costing
 - Life cycle cost
 - Research results consideration
 - Expense vs. speed and quality
 - Sustainability
 - Appropriateness of technology
 - Appropriateness for client entity
- Owens Lake critique
- Applicability to Salton Sea

Vegetation with micro-irrigation

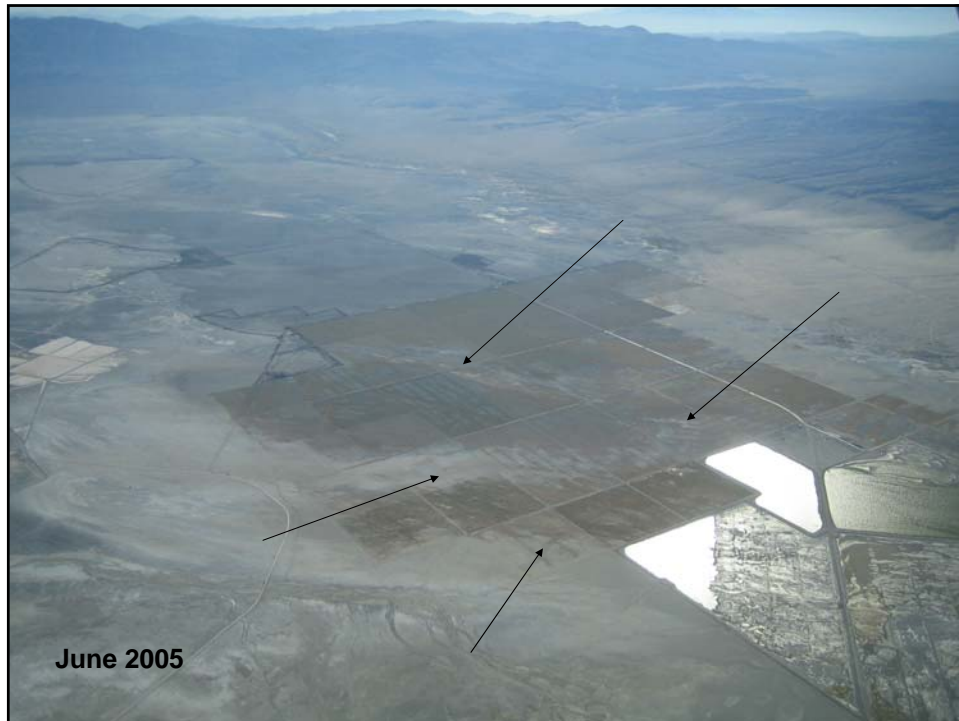
- Use of micro-sprinklers and small orifice tubes to contribute water to plants
- High coefficient of uniformity and of distribution
- Good for uneven surfaces
- Very effective and very efficient
- Susceptible to fouling especially with high TDS /TSS water, or biologically active water

Vegetation on drip: critique of current proposal

- Short life of hose: agricultural uses usually show about 3-5 years even subsurface
- Filtration issues: New and Alamo River water is extremely high in TSS and biologically active algae
- Even with good agronomic luck, 5-7 years for good control with shrubs
- Drainage spacing critical even for low leaching fractions. Failure to get drainage right compromises the project from the beginning
- Life cycle cost issues
- Has a definite life and will have to be replaced (self-recruitment not certain)
- Risk of failure: many moving parts, inputs, coordination, requirement for high husbandry skills that may not be present
- Perpetual inputs: will require water, maintenance, labor, and materials in perpetuity



Site for
managed
vegetation
on drip tubes
at the Owens
Lake



**An alternative for a vegetation measure:
Furrow irrigation of saltgrass or other plants
using gated pipe**

- Drains can be open or tile: on a stable system, filling with sand is not an issue
- Reclamation of soil is a single event
- Reliability high due to large rooting zone for stored water; minimal infrastructure to fail
- Low water use when established: comparable to desert shrubs on drip
- Drainage disposal not a problem– put it in the salt flats
- Not suitable for all soils or all slopes



Evaluation of vegetation as a DCM

- Effectiveness:
 - Documented at Owens Lake and elsewhere
 - has to be +/- continuous cover, no areas to blow out or scour
- Efficiency:
 - Compare costs (initial, FAC, LCC) for drip system and for gated pipe system
- Sustainability
 - Reliability and risk of failure
 - Infrastructure life cycle
 - Input requirements: water, labor, materials

Cost considerations for vegetation with furrow irrigation and gated pipe

- Typically gated pipe costs from one third to one half as much as high-tech, high-input micro-irrigation methods, both for initial capital costs **as well as** for operation inputs and replacement.
- Should have a longer material life
- Fewer inputs such as filtration, and fewer amendments such as scalants

Salt flats: slurry

- Created from brine pool feedstock
- Designed for **permanence**, not a temporary measure.
- Wet salt bed or slurry would remain saturated
- Evaporation rate very low
- Can use any water for saturation, such as drain water or brine pool water (preferred). Freshwater consumption not required
- Minimal infrastructure to construct. All permanent, no mobile equipment or material: appropriate technology
- No habitat value, so no environmental liability



Evaluation of salt slurry

- Effectiveness
 - If saturated, no risk of emission
 - No period of emissive potential
- Applicability
 - More suitable for silt and clay, and for flat topography
 - Ample salt availability
- Appropriateness:
 - Low tech
 - Easy to manage
 - Low on-going operation/maintenance costs

Solid Salt Flats

- Permanent measure
- Need about 4 feet of brine at 35 ppt to grow 4 inches of solid salt
- Salt bed is of sodium chloride, which is non-emissive and enduring
- Simple technology for construction and maintenance
- Resting and refuge habitat for plovers

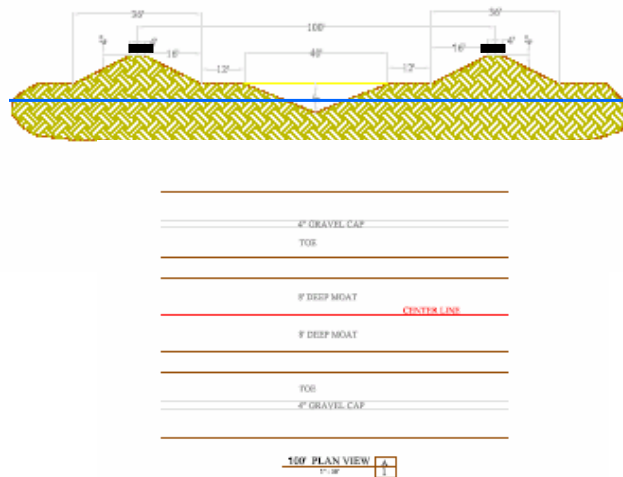


Evaluation of salt flats

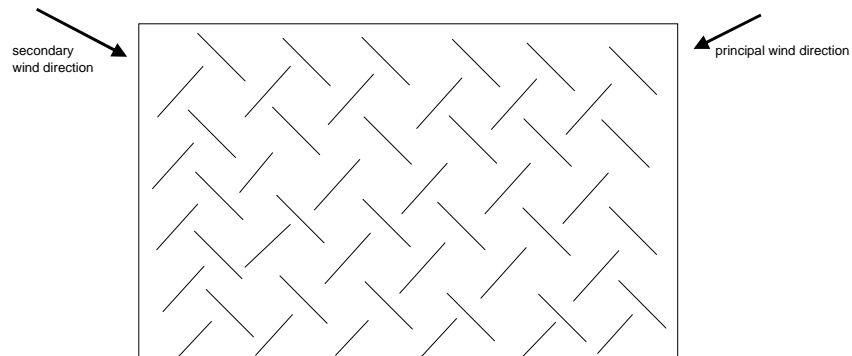
- Effectiveness:
 - Chemistry of salt is very important, and is well-known for the Salton Sea
 - Saturation would not be required, as the salts are already stable
 - Evaluation of the importance of surface disturbance should be performed
- Applicability:
 - Plenty of salt resource
 - Better for shallow slopes and unfractured clay soils
- Appropriateness:
 - Longevity should be evaluated
 - Low tech solution, anticipated easy to manage

Gravel

Moat and row with gravel cap



Conceptual layout



How it works

- Physical barrier: extremely high surface roughness factor
- Wind speed reduction
- Physical trap for moving particles
- Exposed surface (top, and leading edge berm sides) capped with gravel. Between 5-10% of surface has to be covered.
- Gravel placed with excavator bucket; delivered with truck. Standard equipment, nothing special
- Low maintenance: if gravel fills in, can place sprinkler on top, or re-cap.

Evaluation of Gravel

- Effectiveness:
 - High anticipated effectiveness
- Applicability:
 - Low FAC and LCC
 - No water consumption
 - Minimal amount of gravel needed
- Appropriateness:
 - Low tech for construction, installation, and maintenance
 - Low risk of failure

Cost Information for Gravel

- One third the capital cost of high-intensity micro-irrigation measures
- About 10% of the annual cost of micro-irrigation measures
- Realistic and practical replacement for measures that have high maintenance requirements
- Longest lived measure proposed

Responsible Economic Analysis

- Full Absorption Costing (FAC)
 - Capital costs
 - Operation and maintenance: include ***all infrastructure components and replacement***
- Life Cycle Cost (LCC)
 - Cradle to grave over ***entire*** life of the project
 - Includes all planning and all decommissioning or replacement

If this is not done, stakeholders make decisions based on only partial cost information

Example at Owens Lake

- FAC (on vegetation control measure at Owens Lake)
 - Drain infrastructure retrofit
 - Replanting
 - Crop failure due to lack of control for flood water and sand movement
 - Unforeseen inputs (e.g. scaling reagents: costs \$500 K the first year)
 - Annual infrastructure replacement: premature component failure
 - Higher additional water input than anticipated
 - Sophisticated managerial oversight required
- LCC activities
 - To date, \$415 million spent at the Owens Lake, and this is only a portion of the total cost of the project
 - Not necessary to repeat those blunders at the Salton Sea
 - All stakeholders taxpayers rate-payers concerned: interdisciplinary review

Critique of Process for dust control measure selection at Owens Lake

- FAC was incomplete: many change orders
- LCC has not been revealed: \$415 M spent to date is not the full commitment required
- Inadequate on-going research after project started, due to funding and stalling from client and consultants
- Started with poor (immature) knowledge base
- Problems with placement and design of shallow flood: thousands of acres is now being retrofitted
- Problems with drain spacing and flash flood water management for vegetation: retrofits required
- Not appropriate technology: designed as sophisticated agriculture rather than as a low-tech approach
- Not entity-suitable: design team states that the vegetation measure is too complex to be easily operated and maintained by the client

Measure Suitability

Surface type	sand	silt	clay	sheet flow	slope	substrate structure	moisture	minerals			
Measure						(cracks)		subsurface salt deposit	subsurface gravel layer	high mineral grade clay	fat clays
Vegetation											
shrubs drip	x			barrier	N/A	unacceptable	drier	unacceptable	acceptable	reclamation difficult	reclamation difficult
grass drip	x			barrier	N/A	unacceptable	wetter	unacceptable	acceptable	reclamation difficult	reclamation difficult
grass gated delivery furrow	x			barrier	utilize slope	unacceptable	wetter	unacceptable	unacceptable	reclamation easier	reclamation easier
wetland strips	x			barrier	utilize slope	unacceptable	wetter	unacceptable	unacceptable	reclamation difficult	reclamation difficult
Habitat shallow flood		x	x	barrier	cheaper on shallow	unacceptable	wet OK	key in berms	unacceptable	less percolation loss	unstable foundation for infrastructure
Salt flats						unacceptable					
crystal body		x	x	barrier	cheaper on shallow	unacceptable	wet OK	key in berms	unacceptable	less percolation loss	unstable foundation for infrastructure
slurry		x	x	barrier	cheaper on shallow	unacceptable	wet OK	key in berms	unacceptable	less percolation loss	unstable foundation for infrastructure
Gravel											
blanket direct on surface	x	x	x	barrier	N/A	N/A	N/A	N/A	N/A	N/A	N/A
blanket with fabric	x	x	x	barrier	N/A	N/A	N/A	N/A	N/A	N/A	N/A
moat and row with cap		x	x	accommodate	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Measure Evaluation

	effectiveness	efficient		sustainability				environ.	risk	appro.	entity	flexibility
		LCC	FAC	water	labor	O&M	replacement	value		tech	appro.	
Vegetation												
shrubs drip	demonstrated	poor	difficult	medium	high	high	5 years	0	high	no	no	high
grass drip	demonstrated	poor	moderate	medium	high	high	5 years	+	high	no	no	high
grass gated delivery furrow	demonstrated	good	moderate	medium	low	medium	15 years	+	medium	yes	somewhat	medium
wetland strips	designed	good	difficult	low	low	medium	15 years	+	medium	maybe	somewhat	medium
Habitat shallow flood	obvious, demo, design	fair	moderate	high	very low	low	40+ years	++	low	yes	somewhat	low
Salt flats												
crystal body	obvious	good	moderate	none	very low	low	40+ years	0	low	yes	somewhat	low
slurry	obvious	good	moderate	very low	very low	low	40+ years	-	low	yes	somewhat	low
Gravel												
blanket direct on surface	designed	fair	easy	none	lowest	lowest	50-> years	0	lowest	yes	yes	highest
blanket with fabric	designed	fair	easy	none	lowest	lowest	50-> years	0	lowest	yes	yes	highest
moat and row with cap	designed	excellent	easy	very low/none	lowest	lowest	50-> years	0	lowest	yes	yes	highest

Some conceptual and experience-based cost estimates

	Planning	Design	Build (\$/acre)	Operate	endow	decommission	LCC TOTAL	percent of highest
	scoping	(\$/acre)	(with other precursors)	(\$/acre)	required		\$/acre	
	placement				(5% yield)	(20% construction)		
micro-irrigated vegetation	incl. build	\$ 4,000	\$ 20,000	\$ 2,000	\$ 40,000	\$ 4,000	\$ 68,000	1.00
shallow flood habitat	incl. build	\$ 4,000	\$ 15,000	\$ 400	\$ 8,000	\$ 3,000	\$ 30,000	0.44
salt pan armor	incl. build	\$ 4,000	\$ 10,000	\$ 200	\$ 4,000	\$ 2,000	\$ 20,000	0.29
gravel	incl. build	\$ 4,000	\$ 8,000	\$ 50	\$ 1,000	\$ -	\$ 5,000	0.07

Measure	Owens Lake Actual Costs per acre	acres	total	Measure	Salton Sea Projected Costs (Order of magnitude) per acre	acres	total
Micro-irrigated vegetation	\$ 27,000	2,200	\$ 59,400,000	Micro-irrigated vegetation	\$ 15,000	50,000	\$ 750,000,000
Shallow Flood Habitat	\$ 20,000	16,872	\$ 337,440,000	Shallow Flood Habitat	\$ 12,000	0	\$ -
Salt Flat [slurry]	\$ 10,000		\$ -	Salt Flat [slurry]	\$ 10,000	0	\$ -
Gravel [moat and row]	\$ 8,000		\$ -	Gravel [moat and row]	\$ 8,000	0	\$ -
TOTAL			\$ 396,840,000				\$ 750,000,000

The Project "Iceberg"

Measure	Salton Sea Projected Costs (Order of magnitude) per acre	acres	total
Micro-irrigated vegetation	\$ 15,000	10,000	\$ 150,000,000
Shallow Flood Habitat	\$ 12,000	10,000	\$ 120,000,000
Salt Flat [slurry]	\$ 10,000	0	\$ -
Gravel [moat and row]	\$ 8,000	0	\$ -
		20,000	\$ 270,000,000

Measure	Salton Sea Projected Costs (Order of magnitude) per acre	acres	total
Micro-irrigated vegetation	\$ 15,000	2,500	\$ 37,500,000
Shallow Flood Habitat	\$ 12,000	2,500	\$ 30,000,000
Salt Flat [slurry]	\$ 10,000	5,000	\$ 50,000,000
Gravel [moat and row]	\$ 8,000	10,000	\$ 80,000,000
		20,000	\$ 197,500,000

Measure	Salton Sea Projected Costs (Order of magnitude) per acre	acres	total
Micro-irrigated vegetation	\$ 15,000	0	\$ -
Shallow Flood Habitat	\$ 12,000	0	\$ -
Salt Flat [slurry]	\$ 10,000	0	\$ -
Gravel [moat and row]	\$ 8,000	20,000	\$ 160,000,000
			\$ 160,000,000

Measure	Salton Sea Projected Costs (Order of magnitude) per acre	acres	total
Micro-irrigated vegetation	\$ 15,000	0	\$ -
Shallow Flood Habitat	\$ 12,000	0	\$ -
Salt Flat [slurry]	\$ 10,000	0	\$ -
Gravel [moat and row]	\$ 8,000	7,000	\$ 56,000,000
			\$ 56,000,000

DCM's at the Salton Sea

- Strategy for low cost long term dust control has to hinge on the development of an intelligent, responsible footprint such as that which has been presented in the SSA's preferred alternative.
- This means that large portions of potentially emissive areas have become reservoirs, habitat, crystal bodies, and other non-emissive surfaces, leaving 7,000-10,000 acres to be treated
- Should use low cost readily available resources such as sodium chloride or gravel
- Use berms not dikes, low cost, low impact

Recommended selection method for Salton Sea

- Seek **permanent, walk-away** solutions using available resources that can be made effective quickly
- Match the substrate area to the control measure
- Use **appropriate technology** with very low on-going operation and maintenance requirements
- Seek lowest possible overall water use, and use of lowest quality water
- Utilize **FAC and LCC in financial determinations**. Initial cost as the principal selection criterion reflects “tip of the iceberg” mentality
- Fully detailed and timely **peer review** by all stakeholders and agencies using an interdisciplinary approach